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HCMM Energy Budget Data As a Model Input For Assessing Regions of High Potential Groundwater Pollution

(E79-10002) HCMM ENERGY BUDGET DATA AS A MODEL INPUT FOR ASSESSING REGIONS OF HIGH POTENTIAL GROUND-WATER POLLUTION Interim Report, Jul. - Sep. 1978 (South Dakota State Univ.) 9 p HC A02/MF A01 CSCL 13B G3/43

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A. Problems

Notification was not received regarding the August 11, 1978, WB-57F overflight with the RS-18 scanner until after the flight. As a result, ground data in support of the mission were not collected but were delayed by one week because of clouds making the aerial data less useful in the final analysis.

B. Accomplishments

Collection of ground data in support of HCMM overpasses has been completed. Analysis of the ground data has begun.

Field experiments were conducted to evaluate effects of soil moisture and crop cover on surface and subsurface soil temperatures. Data were collected on small barley plots at the Agricultural Engineering Research Farm located near Brookings, South Dakota. One plot was irrigated to increase its soil moisture while the other was left as a dryland plot. Soil temperatures were measured with thermocouples buried at depths of 1, 5, 10, 25, 50 and 100 cm. Thermal emittance was measured for both plots using a Barnes PRT-5 infrared radiometer mounted on a scanning apparatus. Net radiation, incoming solar radiation and other select data were also collected. These data were collected for six successive diurnal cycles. The barley plants were removed from the plots for the last three days of data collection. Analysis of this data is presently underway.

A second set of soil temperature data were collected during the summer on two corn fields where thermocouples were buried at depths of 5, 10, 25, 50 and 100 cm. Attempts to use the finite-difference heat flow model to simulate soil temperatures in terms of soil moisture and percent cover have been quite successful. Results comparing measured and simulated soil temperature will be presented in future reports.

During the next reporting period, analysis of the ground data will continue. Analyses of aircraft and HCMM data to evaluate effects of depth to water table, soil temperature, soil moisture, and percent crop cover to thermal emittance will begin upon receipt of the data.

C. Results

A major assumption of the HCMM investigation is that the occurrence of shallow aquifers produces a heat sink that influences subsurface and surface temperatures (Cartwright, 1968a). Cartwright (1968b) found that soil temperatures measured at a 50-cm depth over an aquifer were cooler in the summer than those over the surrounding landscape.

During daylight hours on September 5-7, 1978, a series of 50-cm temperatures were measured by copper-constantan thermocouples at locations where operational observation wells existed to verify the findings of Cartwright. The temperatures were measured for several soil types, cultural practices and land use categories.

Results indicated a highly significant (0.01 level) positive correlation between 50-cm soil temperatures and depth to water table up to three to four meters (Fig. 1). Significant correlations were not obtained at depths greater than about four meters. The relationship was significant for row crops (corn, soybean, sunflower and sorghum) and pasture (improved and unimproved). Fields of bare soil and stubble in which soil temperatures were measured were too few to draw any conclusions for those two land use categories. The results shown in Fig. 1 appear to support the assumption that shallow water tables produce a heat sink effect. Aircraft and HCMM data will be used to evaluate the effect of the heat sink on thermal emittance from the soil surface.

Soil moisture can significantly influence surface thermal emittance and affect interpretation of thermal data for locating shallow aquifers. A series of theoretical model calculations were made to investigate the effect of soil moisture profiles on the surface temperature. Surface temperatures were calculated as a function of time for various moisture profiles. Figure 2, a typical result of these calculations, shows the dry plot to be warmer during the day and cooler during the night with a zero difference at approximately 0800 hours and 2100 hours. Temperature differences at about 1400 and 0600 hours are very dependent on the difference in soil moisture. Preliminary analyses of field measurements has shown good agreement between model calculation and field measurements of soil temperature.

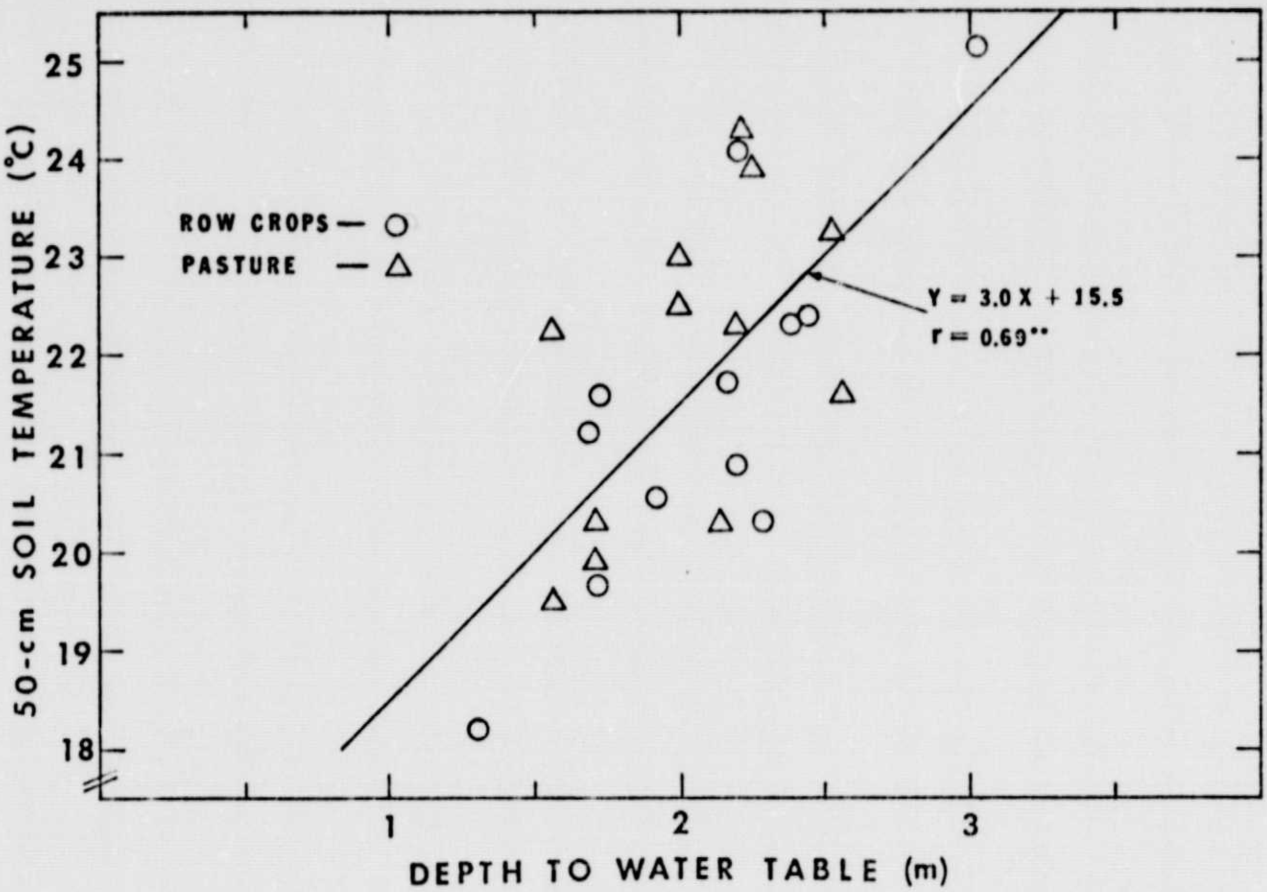

Fig. 1. Relationship of 50 cm soil temperatures to depth to water table for row crops and pasture.

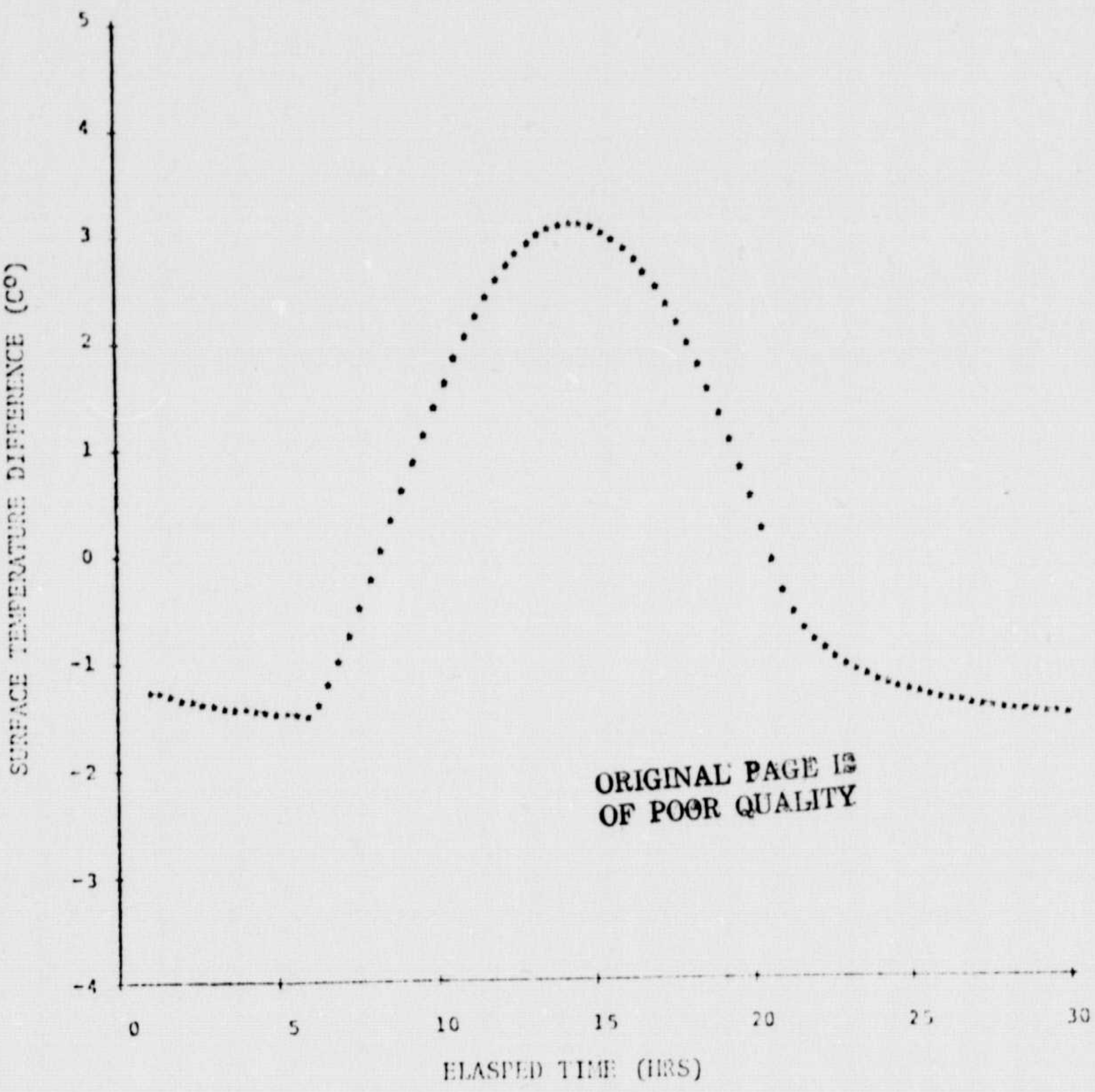

Fig. 2. Surface temperature difference as a function of time obtained by subtracting the calculated surface temperature of a plot with 30% soil moisture by volume from that calculated for a similar plot with 15% soil moisture by volume. The plot begins at 2400 hours.

References

Cartwright, K. 1968a. Thermal prospecting for groundwater. Water Resources. Res. 4:395-401.

Cartwright, K. 1968b. Temperature prospecting for shallow glacial and alluvial aquifers in Illinois. Illinois State Geological Survey Circular 433, Urbana, Illinois.

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